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ABSTRACT

This study was designed to investigate the effects of modeling or training with and without rule provision on the employment of strategies in solving four-dimensional, discrimination-learning problems. Subjects were 144 second and sixth-grade children from the New York City Public Schools. The blank-trial hypothesis testing paradigm was used. The children were individually pre-trained to familiarize them with the stimuli and the blank-trial methodology and then exposed to one of three 10-minute videotapes. Four problems were presented and solved by a modeling subject on each tape. Three tapes were used: one modeling focused checking, one modeling dimension checking, and a control tape. Strategies used by children fell into five categories: focused testing, dimension checking, hypothesis checking, stereotypes and unsystematic. Charts show the percentages of pupils using the various strategies after exposure to the experimental and control conditions. A number of implications are drawn from the data. Of note is the large percentage of focusing elicited among sixth graders after exposure to the focusing and control tapes compared with very little focusing elicited from second graders under any experimental conditions. (MS)

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DIFFERENTIAL EFFECTS OF MODELING TWO STRATEGIES ON INFORMATION-PROCESSING EFFICIENCY AMONG ELEMENTARY-SCHOOL CHILDREN

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This study was designed to investigate the effects of modeling or training with and without rule provision on the employment of strategies in solving four-dimensional, discrimination-learnin problems. The subjects were second and sixth grade children from New York City Public schools. Using the blank-trial, hypothesis testing paradigm, Levine showed that adults manifest hypotheses which are sensitive to feedback on more that 90% of the blank-trials administered in four-dimensional problems.

Figure one shows the type of stimuli used. The four dimensions in the current experiment were size, color, alphabetic letter and line position. Each dimension had two values: large and small, T and X, black and white, and line on the top and line on the bottom. The size and line positions remained constant from problem to problem while the colors and alphabetic letters changed. The stimuli were arranged so that an hypothesis could be inferred from the unique pattern of three responses to one side and one response to the other side a subject made on the four no-feedback stimulus cards that made up a blank-trial probe. For example, a subject whose hypothesis was black would chose the stimulus array that contained "black" on all four cards and he would (as can be seen on the first column of the left) choose the stimulus array on the left on the first three cards and the stimulus array on the right on the last card.

Gholson (e.g. Gholson et al., 1972) extended the methodology to children and found that the behavior of elementary-school children was also strongly systematic. Elementary-school children manifest hypotheses on more than 85% of their blank-trial probes. Moreover, just as a subject's hypothesis could be in-

ferred from his pattern of responses during a blank-trial probe, the strategy he was using could be inferred from the sequence of hypotheses manifest. Three distinct strategies have been delineated. For the purpose of examining strategies, assume that the four stimulus cards presented in figure one are all feedback trials. One feedback trial is inserted after each blank-trial probe so that the subject receives feedback on trial one, then a four-card, blank-trial probe, then a feedback care and so on.

The most efficient strategy is termed <u>focusing</u>. Assume that the feedback was preprogrammed so that whatever his hypothesis, the subject received negative feedback on each of the first three feedback trials. A subject who is focusing considers all four of the values in the positive stimulus array. Therefore, if the subject chooses the stimulus array on the right and is told that the stimulus array on the left contains the correct answer, he will consider large, black, T and line on the top as possible solution hypotheses. He must then hold all four possibilities in memory while he manifests just one during the blank-trial probe that follows. At feedback two the focusing subject who has, for example, manifested large on the previous blank-trial probe will choose the stimulus array on the left (the large, black, X, with the line on the bottom) and he will be told that the correct hypothesis is on the other stimulus array, the one containing the small, white, T, with the line on the top. At this point, he must mentally compare the correct stimulus array at feedback one with the correct stimulus array at feedback two. A focusing subject will eliminate large and black from the set of possible solution hypotheses since, while they were in the correct stimu-

his array at feedback one, they are not in the correct stimulus array at feedback two. The focusing subject now must consider T and line on the top as possible solutions. If he tries T on the next blank-trial probe and is told that the correct answer is in the other stimulus array (the large, white, X, with the line on the top) he will eliminate T as a possible solution. That leaves him with line on the top as the only possible solution. A focusing subject will always have the solution hypothesis after three feedback trials.

A subject who is dimension checking is manifesting a less sophisticated strategy in that he does not consider all the possible hypotheses at once but rather tests one dimension at a time, e.g., he may try T but recognizes that if T is not in the correct stimulus array on feedback one, he need not try it during a blank-trial probe and need only try its opposite value, in this case X. If X is disconfirmed at feedback two, the dimension checking subject will choose another hypothesis from a new dimension and try that. In this example, since alphabetic letter has been disconfirmed the subject will choose his next hypothesis from among the set of small, white and line on the top. Therefore a dimension-checking subject proceeds through the dimensions one at a time, trying only one value from each dimension and recognizing the logical disconfirmation of the other value on that dimension.

144 second and sixth-grade children were individually pretrained to familiarize them with the stimuli and the blank-trial methodology and then exposed to one of three ten-minute videotapes. One third of the subjects at each grade level were

exposed to each tape. Four problems were presented and solved by a modeling subject on each tape. Only the stimulus cards and the model's and experimenter's hands were seen but the subject saw the model making choices and heard the feedback. The subjects exposed to the focusing tape heard the model's explanation of her choices at each step as well as a summary of the rule underlying focusing before the third modeling problem. For example, the focusing model said "What I have to do is to remember all four of the things in the first correct picture and then which two things are in the first and second correct picture and the third time you tell me which picture is correct I can always tell what the answer is."

The dimension-checking tape showed the same visuals as the focusing tape but with a different voiced-over soundtrack. On this tape the subject saw and heard the model solving the problems using the dimension-checking strategy. A summary of the rule underlying dimension-checking was presented by the model before the third problem.

The subjects exposed to the control tape again saw the same visuals and heard the feedback and the model choosing an hypothesis. However, no strategy was modeled and there was no rule provision.

Several previous studies by Gholson et al., without modeling, have shown that elementary-school children manifest focusing on less than 10% of the problems presented. The modal strategy used by both second and sixth graders without modeling is dimension checking which is manifest on approximately 50% of the problems

presented. Without modeling, second and sixth graders show very similar patterns of strategy production.

Figure two shows the percentage of problems in the current study that were categorizable in terms of strategies after exposure to each of the modeling tapes. A problem is categorizable when the subject produces an hypothesis, sensitive to feedback, on the first three blank-trial probes. It is evident that among sixth graders the percentages of categorizable problems are approximately equal after exposrue to each of the tapes. However, if the percentages for the second graders are examined, it becomes apparent that only after exposure to the dimension-checking tape do second graders produce problems that are categorizable at a rate anywhere close to the production rate of the sixth graders. The percentage of categorizable problems for the control tape lies between that of the focusing and dimension-checking tapes. These results indicate that for second grade children, only when the modeling and rule provision is congruent with their modal strategy without modeling do the subjects come close to the sixth graders in their production of categorizable problems. Exposure to the focusing tape depressed performance among second graders on all dependent measures. This data will be presented in a later paper.

Figures 3, 4, & 5 show the differences in hypothesis-sampling systems between second and sixth grade children after exposure to each of the modeling tapes. Figure 3 shows the percentages after exposure to the focusing tape. As can be seen, the percentage of focusing is less than 6% for second graders. The sixth

graders with modeling and rule provision manifest more than 55% focusing, a dramatic difference not found without modeling. The rest of the percentages reflect that difference, that is, if a subject is producing categorizable problems and he is not focusing, he must be manifesting dimension checking, hypothesis checking, a stereotypic pattern or a random pattern. An hypothesis checking subject checks each value of each dimension, one at a time, e.g. large and then small, then T, then X and so on until he finds the solution. A stereotyping subject of elementary-school age is almost always showing a stimulus preference, that is, he may continue to choose "large" even after disconfirmation. As can be seen, no sixth graders showed stereotypes after exposure to the focusing tape but 15% of the second graders did. This data is in line with previous data without modeling. Subjects who manifest random hypothesis sequences are forming hypothesis which are sensitive to feedback but their sequences of hypotheses do not follow an identifable plan.

Figure four shows the percentages of hypothesis-sampling systems for the two grades after exposure to the dimension-checking tape. In this condition, the second and sixth graders do not differ in the percentage of dimension checking manifest although they do differ in terms of the hypothesis-sampling system manifest when the model's strategy is not employed.

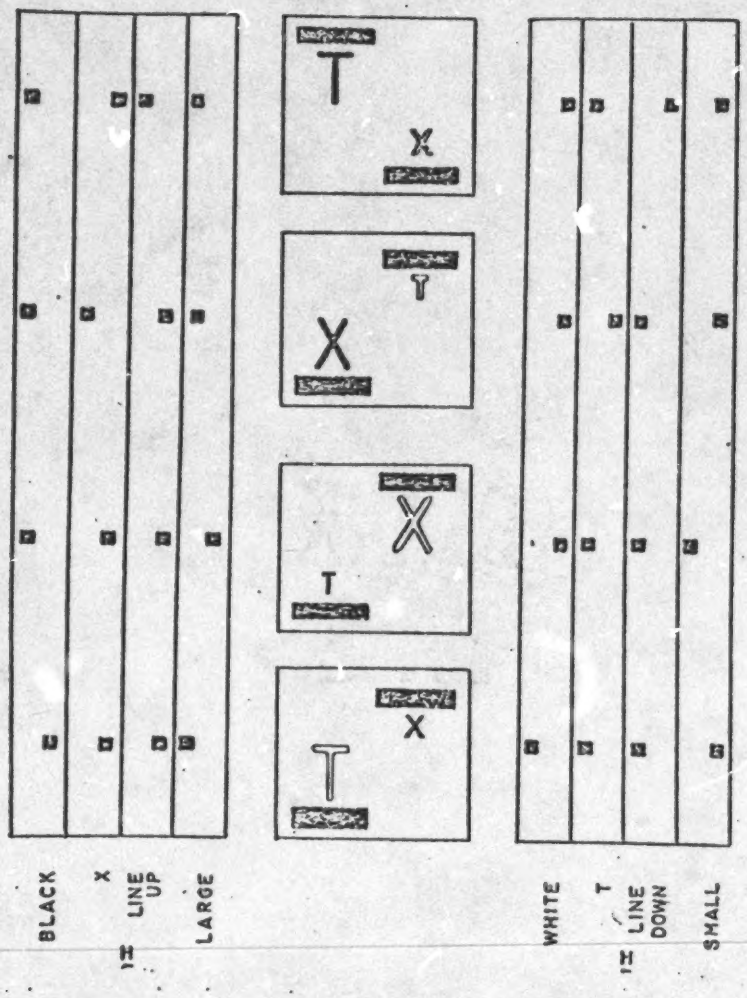
This trend can be seen even more clearly in Figure five which shows the percentages after exposure to the control tape. The control tape does not model any strategy and no rule is provided but the processes that are essential to the generation of any strategy, such as maintaining a confirmed hypothesis and

changing a disconfirmed hypothesis are modeled. Therefore, the subjects exposed to the control tape should be imposing their own cognitive organization on the experimental problems. Again, as in the studies without modeling, dimension checking was the modal strategy employed and approximately equally often by second and sixth-grade subjects. However, when not manifesting dimension checking, the second graders manifested hypothesis checking, stereotypes, and random pattern while the sixth graders primarily manifest focusing.

The large percentage of focusing elicited among the sixth graders after exposure to the focusing and control tapes compared with very little focusing elicited from the second graders under any experimental conditions led to the hypothesis that there may be qualitative as well as quantitative differences between the two age groups. One possibility is that second-grade children do not have the capacity to carry four and then two hypotheses in memory at the same time that they must manifest only one hypothesis during each blank-trial probe. In addition, they may not understand the complex rule which would enable them to logically confirm or disconfirm one than one value at a time and a focusing subject must eliminate two hypotheses at feedback two and one more at feedback three.

Alternatively, manifestation of focusing and dimension checking may be stage dependent in a manner that involves more than the gradual elaboration of memory and inferential capacities with time and experience. Towards elucidating this difference, a study is currently being run in which sixth-grade children are being pretested for Piagetian stage and exposed to the focusing

tape, the control tape or a non-modeling condition. If the difference is stage dependent, rather than age dependent, it is expected that the concrete operational subjects will not manifest focusing under any of the conditions while the formal operational subjects may manifest focusing under all conditions. If the formal operational subjects focus and the concrete operational subjects do not, then further studies into the contributions of memory and logical inference to the manifestation of the difficult but efficent focusing strategy seem warrented.



Each of the four cards in the center consists of two stimulus arrays, each containing one of the two cues of each of the four dimensions. The entire set of four cards constitutes a blank-trial (no feedback) probe. On either side are the eight patterns of right and left choices made to the stimulus arrays that correspond to the eight different hypotheses that can be manifest during a blank-trial probe.

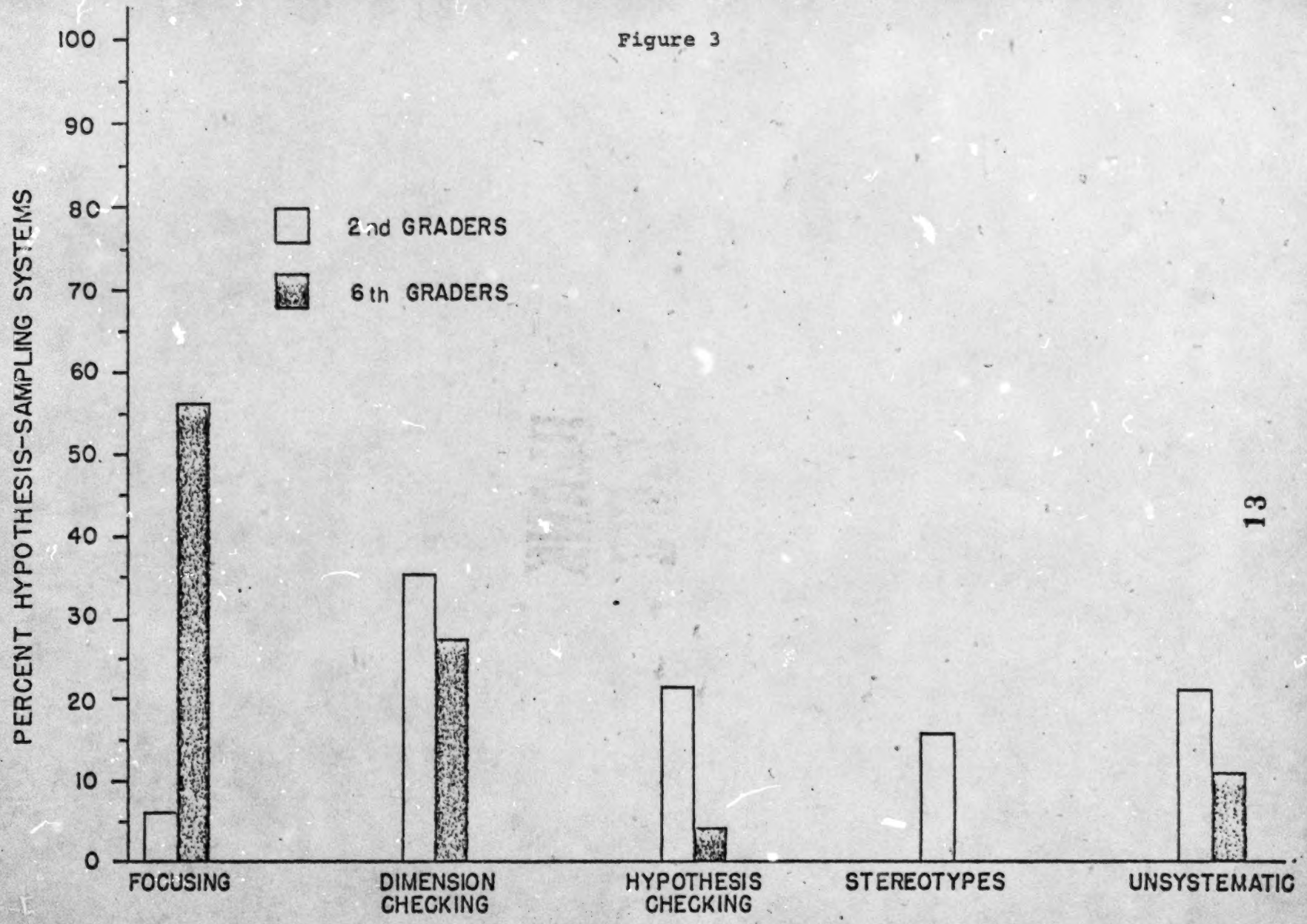
Figure 1

Figure 2

Percentage of Categorizable Problems for Second and Sixth Graders After Exposure to Each Tape

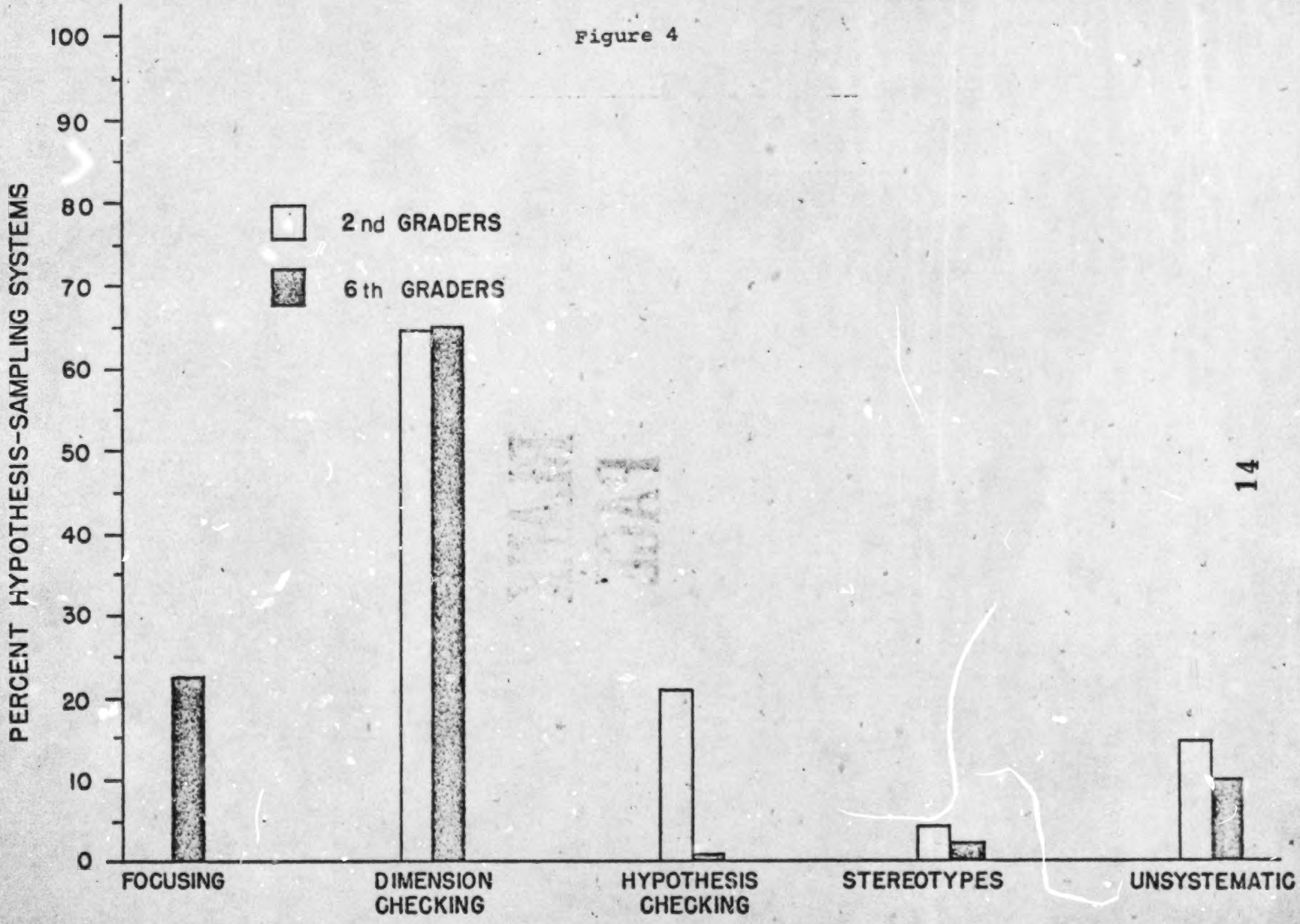
Grade	Tape Exposure Condition		
	Focusing	Dimension Checking	Control
2nd	43.16	73.47	53.33
6th	78.19	83.73	78.04

Figure 3



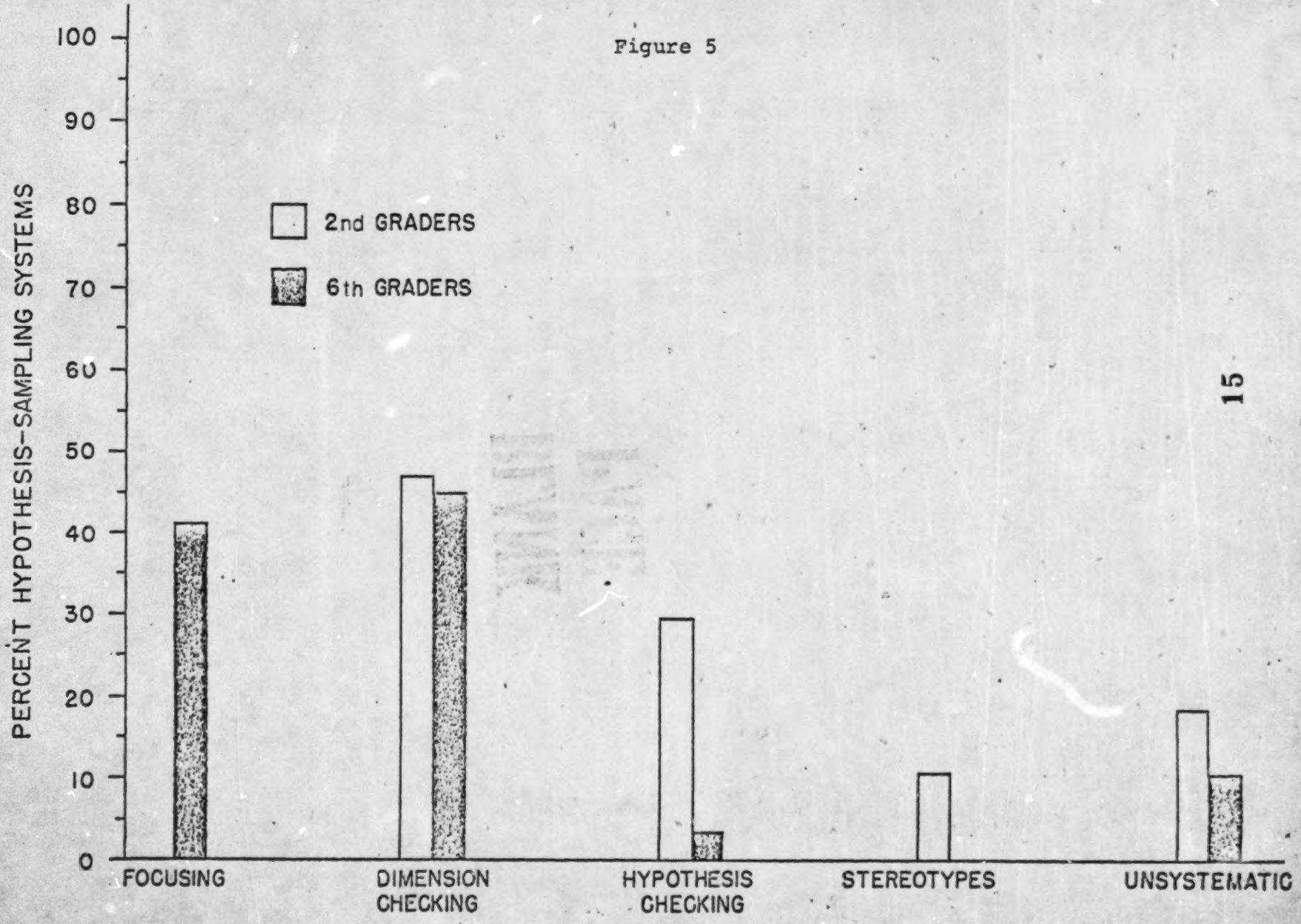
PERCENTAGES OF HYPOTHESIS-SAMPLING SYSTEMS FOR SECOND AND SIXTH GRADERS AFTER EXPOSURE TO THE FOCUSING TAPE

Figure 4



PERCENTAGES OF HYPOTHESIS-SAMPLING SYSTEMS FOR SECOND AND SIXTH GRADERS AFTER EXPOSURE TO THE DIMENSION-CHECKING TAPE

Figure 5



PERCENTAGES OF HYPOTHESIS-SAMPLING SYSTEMS FOR SECOND AND SIXTH GRADERS AFTER EXPOSURE TO THE CONTROL TAPE